In transport

AN UPDATE

Dr Arnab Chatterjee

New Business Development, Hydrogen and Battery Electric

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About Shell
in 2017

86,000

Average number of people we employed

$35.6 billion

Cash flow from operating activities

30 million customers

Served every day through 44,000 Shell-branded retail stations

33.2 million tonnes

LNG liquefaction volumes

70+

Number of countries in which we operated

50%

Share of our production that was natural gas

9 billion

Litres of biofuels blended in the petrol and diesel we sold

3.7 million

Our production of crude oil and natural gas, in barrels of oil equivalent a day

66 million

Tonnes of LNG we sold

$922 million

spent on research and development

$111 million

Spent on voluntary social investment worldwide

1+ million tonnes

Amount of CO_2 captured by Quest CCS facility in 2017

Shell: who are we and what do we do?

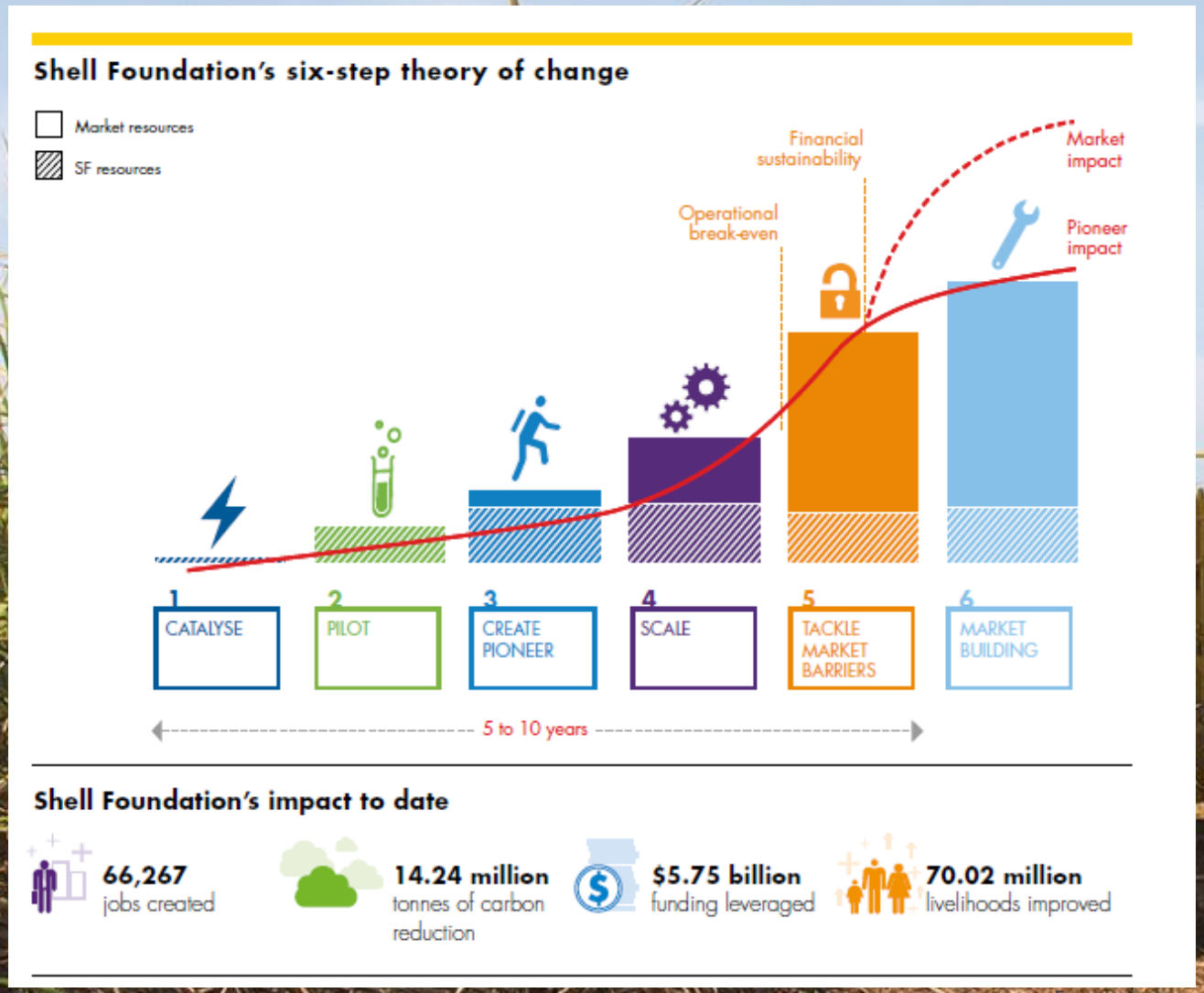
50% reduction of CO_2 (Scope 3) by 2050

- 2% share of world oil production
- 1% share of global energy supply
- 25 B USD Capital invested
- 4.3 B USD quarterly profits (2017 Q4)
- 1 plane every 8 seconds filled with Shell fuels
- Carbon offsets offered at Gasoline stations (EU)

Existing Cash Engines And Asset base

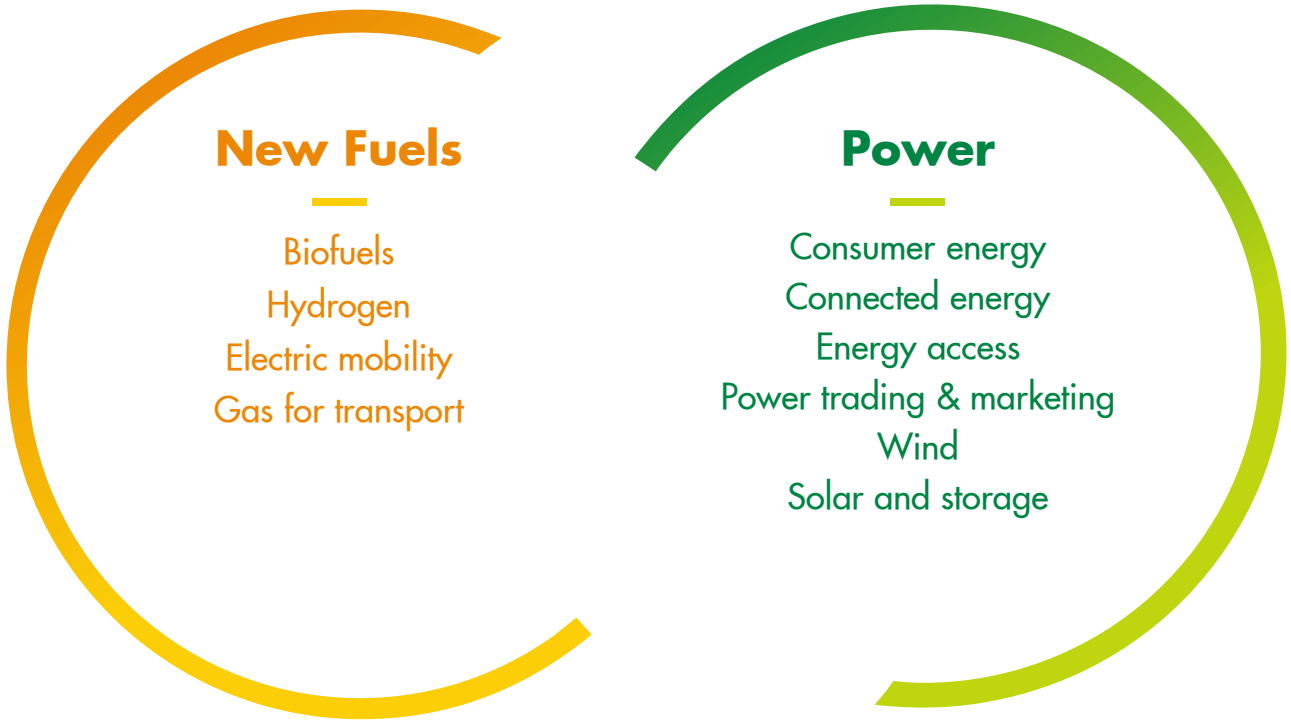
A Continued Investable Opportunity

Working together with Nature Based Solution Partners



- Partners include
  - IUCN, Wetlands International, The Nature Conservancy and Earthwatch
  - Oil and Gas Climate Initiative (OGCI)

New Energies



• Digital businesses • Shell ventures • City solutions •

New Energies

Investments, acquisitions and ventures

New Energies business established

2001-2015

- US 6 Onshore wind **USA, since 2001**
- NoordzeeWind **Netherlands, since 2002**
- Raízen advanced biofuels **Brazil, 2011**
- Hydrogen Stations **Germany, 2015**

2016

- Sense Home Monitor **USA**
- FitCar** **USA**
- Kite Power Systems **UK**
- Borssele 3&4 **Netherlands**

2017

- Hydrogen Stations **UK**
- SBI BioEnergy **Canada**
- IH2 **India**
- Connected Freight ** **Philippines**
- Sunseap **Singapore**
- Stockton on-site **USA**
- Hydrogen Stations **California**
- Innowatts **USA**
- Greentown Labs **USA**
- First Utility **UK**
- Solar Now * **Uganda/Kenya**
- Steamaco * **Africa/Asia**
- New Motion **Europe**
- Fare Pilot ** **UK**

2018

- Husk Power * **India/Tanzania**
- Moerdijk solar **Netherlands**
- Silicon Ranch **USA**
- Rheinland Hydrogen Electrolyser **Germany**
- Heavy duty Hydrogen station **California**
- HyET **NL**
- Axiom Exergy **USA**
- GI Energy **USA**
- Sonnen * **Germany**
- SunFunder * **Kenya**

Energy Solutions
Digital Businesses
Energy Access
Wind
Solar
New Fuels
Shell Ventures

* Minority investment
** Product launch date

Hydrogen as a transport fuel

Benefits

Use of hydrogen fuel

Production of hydrogen fuel

Improve air quality in short term

Fuel cell electric vehicle convert compressed hydrogen into electricity. The only exhaust emissions from a fuel cell vehicle is water vapour.

Low-carbon transport in the longer term

Hydrogen can help reduce CO_2 emissions from transport if it is made from renewable or low carbon sources:

- Using electrolysis and electricity from renewable sources
- From biogas
- From natural gas with CCS

Hydrogen as a transport fuel

How is hydrogen produced?

Hydrogen can be produced by:

Natural gas reforming

Methane can be converted into hydrogen.

Methane from biogas

Gasification

Hydrogen can also be made from organic materials like agricultural waste

Electrolysis

Splitting water with electricity releases hydrogen and oxygen.

Electricity from renewable sources

Hydrogen as a transport fuel

Production of hydrogen

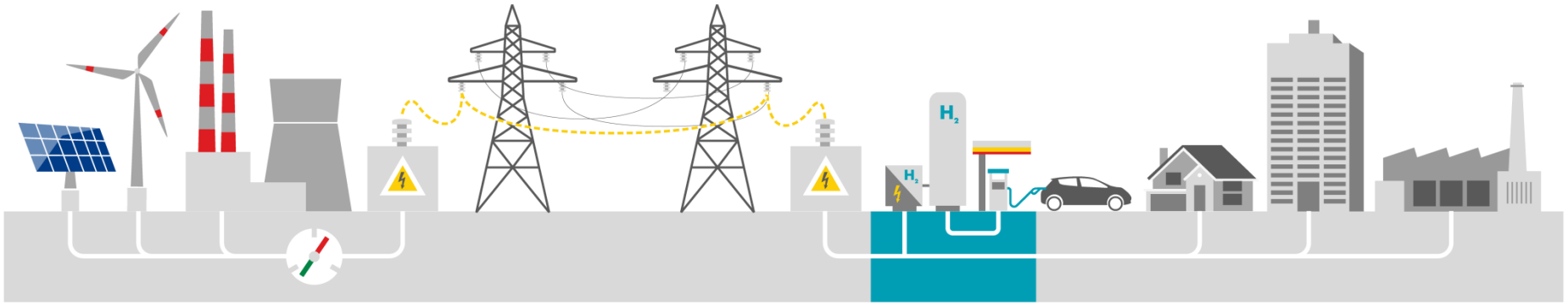
CO_2 reduction:

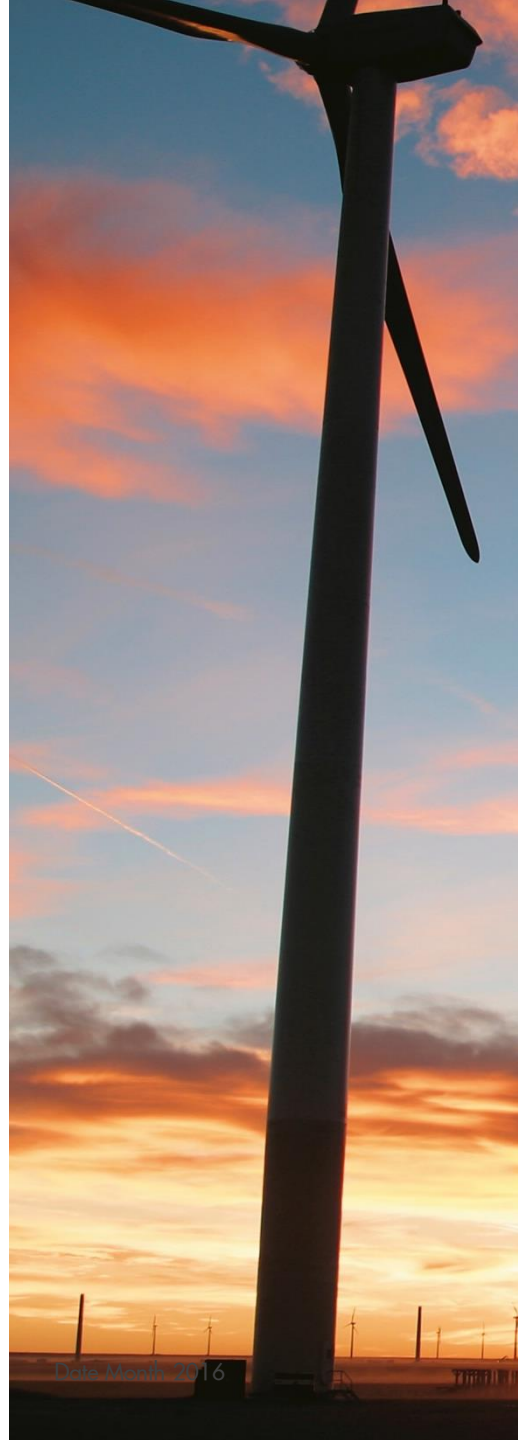
Hydrogen can be made with electricity from renewable sources or using biogas.

Hydrogen can help balancing the electricity grid

The production of hydrogen can use electricity which would otherwise be lost to be stored and used to power cars

This helps to optimize the power markets and balance the intermittencies brought by the introduction of more electricity from renewable sources.





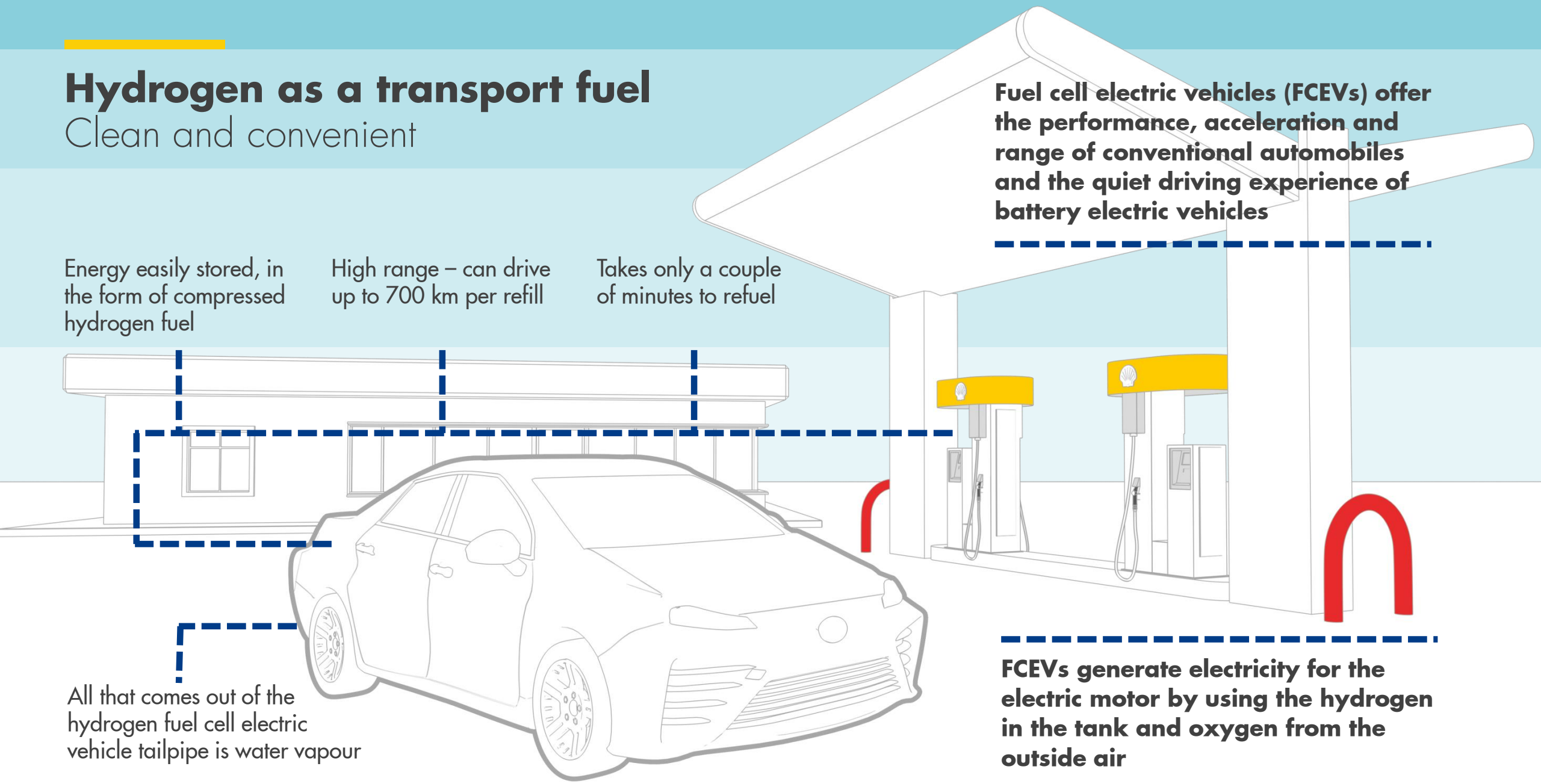
Hydrogen as a transport fuel

Clean and convenient

Energy easily stored, in the form of compressed hydrogen fuel

High range – can drive up to 700 km per refill

Takes only a couple of minutes to refuel



Fuel cell electric vehicles (FCEVs) offer the performance, acceleration and range of conventional automobiles and the quiet driving experience of battery electric vehicles

FCEVs generate electricity for the electric motor by using the hydrogen in the tank and oxygen from the outside air

All that comes out of the hydrogen fuel cell electric vehicle tailpipe is water vapour

The Shell hydrogen journey

Hydrogen stations opening

2010
- Torrance (LA) — USA

2011
- Berlin — DE

2012
- Newport Beach — USA

2013
- Hamburg Bramfeld — DE

2015
- H_2 Mobility JV founded — DE
- Hamburg Schnacken-burgallee — DE

2016
- Wuppertal Geisingen — DE

2017
- Frankfurt
  Wiesbaden
  Sindelfingen
  Pforzheim
  Bremen — DE
- London: Cobham — UK

2018
- Vancouver — CA
- London:
  Beaconsfield and Gatwick — UK
- 15-20 H2 Mobility stations — DE
- 7 stations operating in California — USA

Collaboration is key for H_2 success

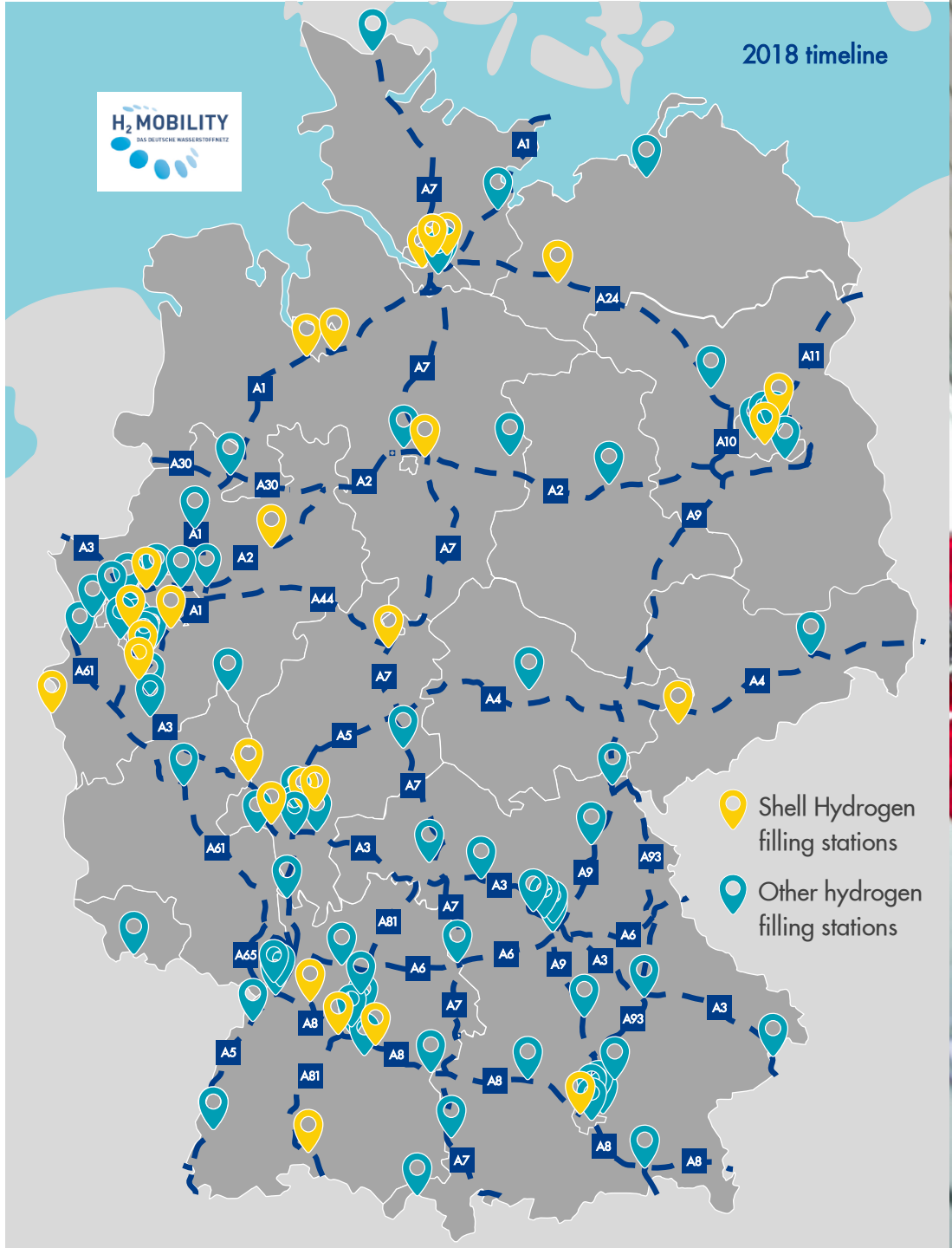
H_2 Mobility in Germany

H_2 Mobility Germany – up and running

- Hydrogen refueling stations network to grow to 400 stations by 2023
- Overall investment of €350mln planned
- Foundation of Joint Venture company by the six shareholders in January 2015
- Example of industry partnership that shares the risks across the value chain, supported by Government

Founding Partners

AIR LIQUIDE · DAIMLER · THE LINDE GROUP · OMV · TOTAL



Collaboration is key for H_2 success

OEM Fuel Cell Electric Vehicles

Brand **Hyundai** Model **?**

Brand **BMW** Model **?**

Brand **Lexus** Model **?**

Brand **VW** Model **?**

Brand **Toyota** Model **?**

Brand **GM** Model **?**

Brand **Hyundai** Model **ix 35 Fuel Cell**

Brand **Daimler** Model **GLC F-Cell**

2013 2014 2015 2016 2017 2018 2019 2020 2021

Brand **Toyota** Model **Mirai**

Brand **Honda** Model **Clarity**

Brand **Symbio** Model **H2 range extender**

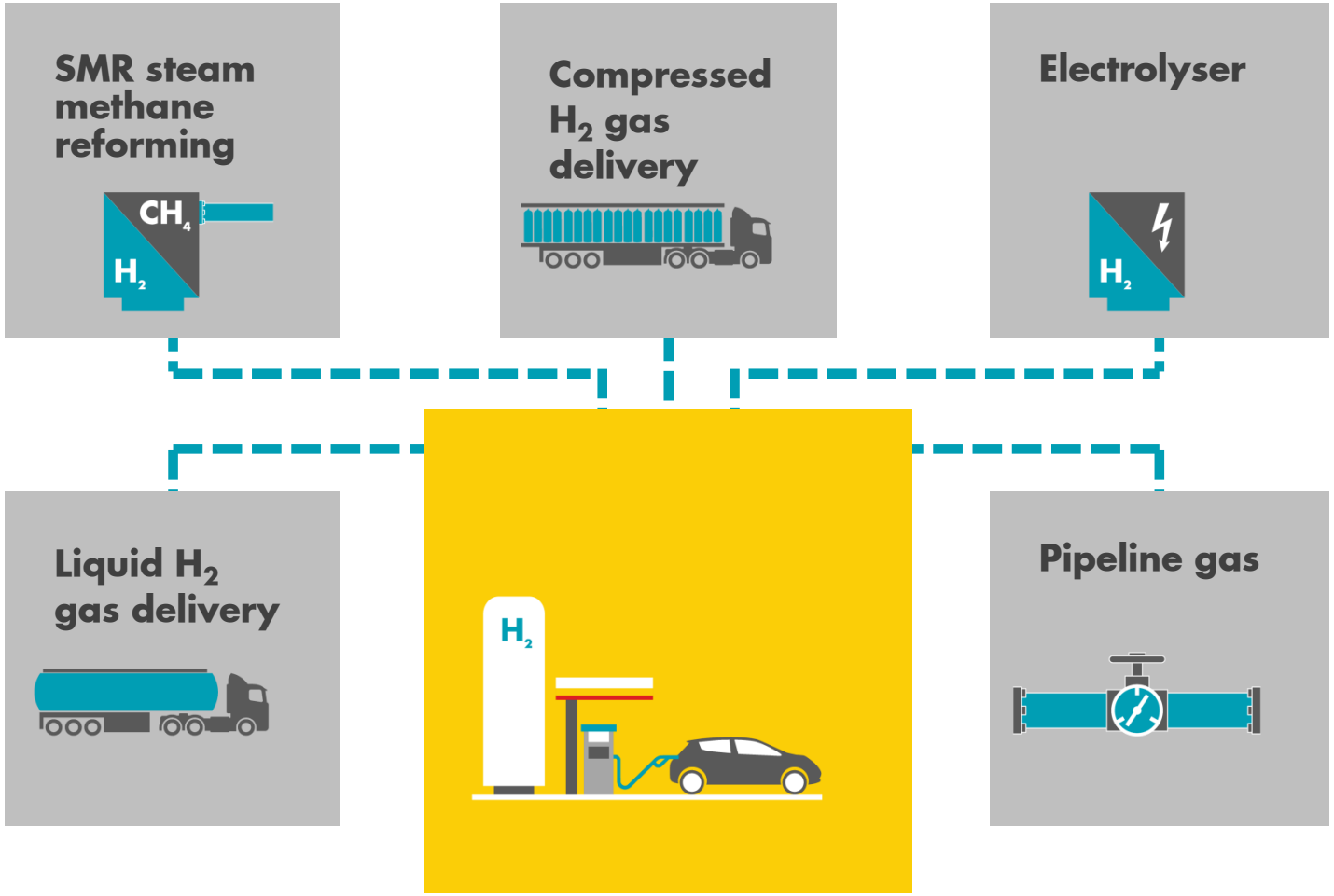
Brand **Toyota** Model **Bus**

Brand **Symbio** Model **H2 Van**

Brand **Nikola** Model **Truck**

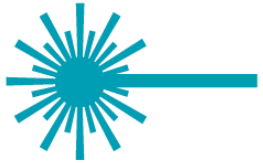
The near future for hydrogen at Shell

H_2 stations testing different supply options

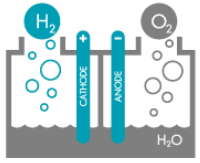


Toolkit: Technology & Product Development

Flow metering

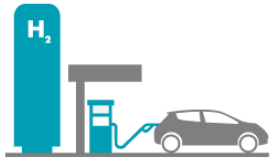


Quality control



Electrolysis

CH2P



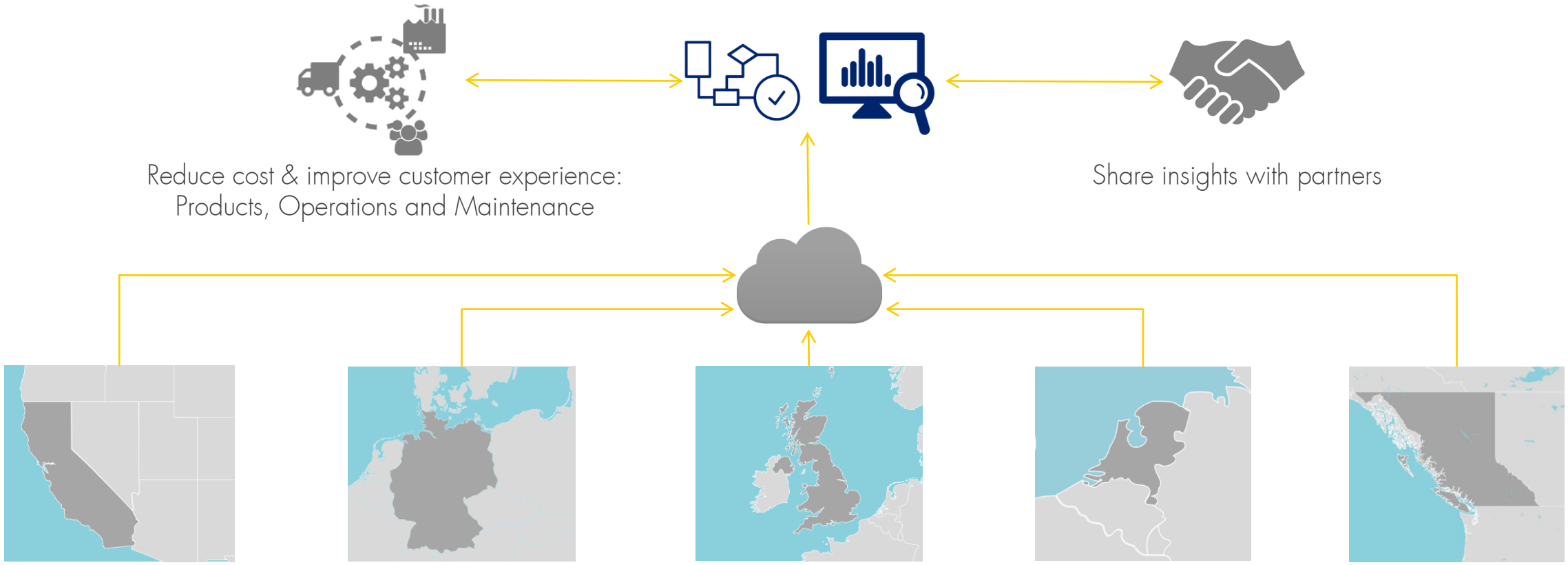
H_2 dispensing

Safety Systems

Control Optimization

Toolkit: Data-driven change

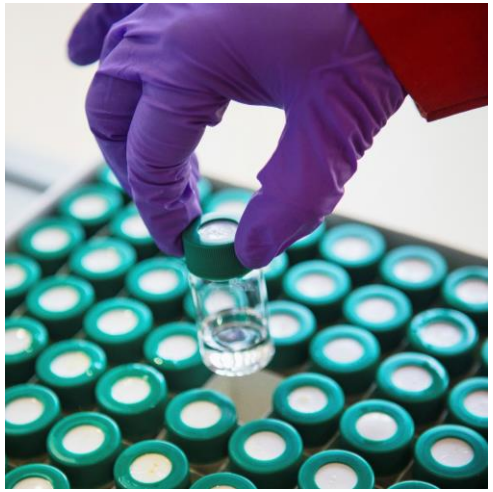
- Data drives cost reduction, performance improvement, and reliability growth
- Realtime data collection from Shell's global H2 refueling infrastructure
- In-house algorithm development, and predictive health monitoring



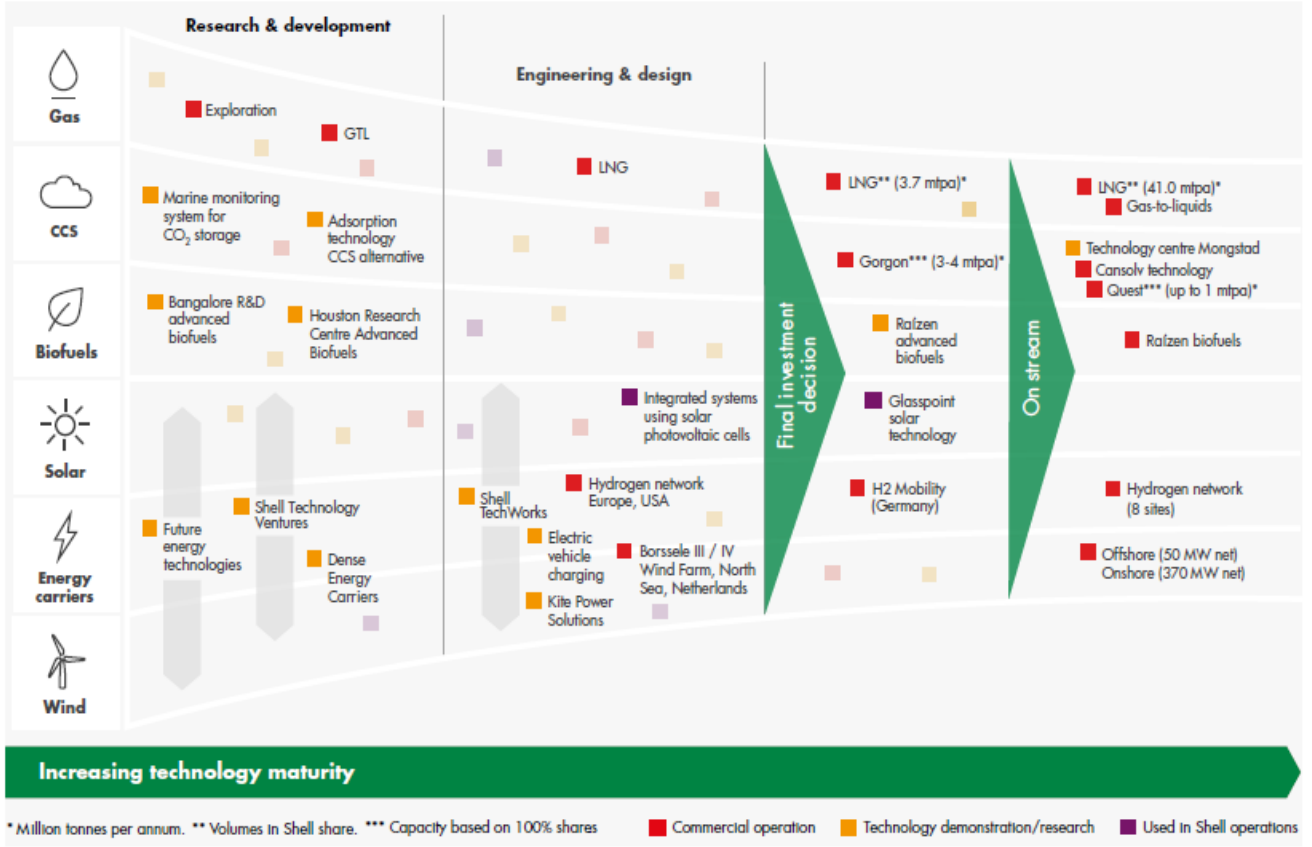
Research and development

Collaborating to commercialise technology

- Global network of Shell technology centres.
- Collaborations with leading universities, such as University of California, Berkeley's (USA) Energy Biosciences Institute and the São Paulo Research Foundation (FAPESP) to conduct research in new energy technology.
- Multi-sector partnerships, such as the Energy Technologies Institute, a public-private partnership between global energy and engineering companies and the UK Government.



Low-carbon research & development investment



Shell Ventures

- Investor and partner in companies developing promising technologies which complement Shell's business.
- Invests in new energy technologies, traditional oil and gas, and information technology.
- Considers companies in all stages of maturity.
- Portfolio includes:
  - Kite Power Systems, a high-altitude wind power generation technology.
  - Tiramizoo, an urban logistics platform focusing on last-mile delivery.

sense

Geli

KPS KITE POWER SYSTEMS

Tiramizoo Delivery

CHRYSALIX ENERGY VENTURE CAPITAL

SET Ventures

Thank you!